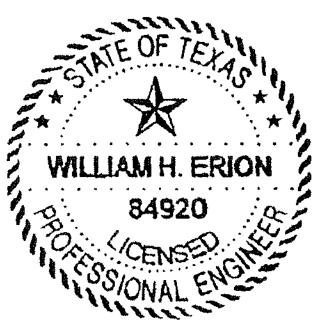
M&E Consultants

Soil & Water Engineering Solutions

Nacogdoches Poultry Litter Storage Building Design Report



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Design Report
Poultry Dry Litter Storage Building

M&E Consultants was engaged by the Nacogdoches Soil and Water Conservation District to Design a Steel Frame Poultry Litter Storage Building. The building has a clear open span of 40 feet, with an eave height of 10 feet. The length of the building is variable with the length determined by the litter storage volume required. Minimum building length is 48 feet. The building consists of steel truss with steel truss legs (columns), wood purlins, sheet steel roofing material and exterior wall of sheet steel siding. The truss legs are attached to a concrete wall 2 feet above the interior floor level. A concrete floor slab is optional. A 4 foot height of treated plywood is attached to the interior side of the wall girts above the 2 foot high concrete wall to allow litter to be stacked against the wall. The exterior metal siding extends up to within two feet of the eave level to provide a 2 foot high opening for ventilation. One end of the building is open and the opposite end is closed with an optional 12 ft x 12 ft door opening. Commercially available trusses with a minimum design loading of 18 psf live load and 4 psf dead load are to be used.

Loads

The structural design of the anchorages for the truss legs considers loading combinations of section 2 ASCE Standard 7 – 02, Minimum Design loads for Buildings and Other Structures. Wind loads were determined based on requirements of ASCE 7-02. The basic wind speed of 90 mph is appropriate for the most of interior portions of the U. S. including Texas, except adjacent to the coast. Wind loads are computed for building risk category 1 (agricultural buildings), exposure category of open farmland, and a rigid structure resulting in a gust factor of 0.85. The building is assumed to not be located on an escarpment or ridge.

The unit weight of the litter was estimated to be 25 lbs per cu ft and the ratio of vertical to lateral stress assumed to be about 1/3 resulting in a lateral load of the stacked material of 8-lb /sq. ft. per. ft. hydrostatic type loading.

The snow load for the central portion of east Texas is 5 psf. This is also equivalent to 1 inch of ice. Ten psf, or 2 inches of ice was used in the design. In addition the structure is designed to be stable for the “minimum roof live load” of 16 psf, which accounts for unspecified live loads.

Analysis

A commercially available truss is manufactured by A&J Construction of Nacogdoches. This truss is designed for 210 lbs per ft (measured on a horizontal plane) in addition to the dead weight of the truss. With truss spacing of 10 feet this is equivalent to a roof load of 21 lbs per square foot (psf) horizontal area. This truss is designed as a three hinged arch. The roof load produces a lateral thrust at the base of the truss leg on the order of 2/3 of the vertical reaction due to the roof load. This thrust is resisted partially by passive resistance of the soil outside of the wall and by the floor slab where the slab is specified. Where a floor slab is not used a counterfort or a pier created by drilling a 12 inch diameter hole and filling with concrete are used to assist in resisting the lateral thrust at the truss locations. The counterfort may be constructed in a short trench perpendicular to the foundation wall. The floor slab is tied to the wall by reinforcing bars enabling the dead weight and friction between subgrade and underside of the slab to be utilized to resist the lateral thrust. Lateral loads on the foundation, in addition to the thrust from truss loading, are produced by the loading of the stored litter against the wall and by wind. The wind may produce horizontal loading either inward or outward depending on orientation of the wind direction. A loading combination in which the lateral load of the litter and the wind are additive was evaluated. It can be assumed the loading operation, in which additional lateral load is put on the wall, does not take place concurrently with the maximum wind load.

Lateral soil loads and resistance is assumed to be that from a soil material with a moist unit weight of 110 lb/cu ft, active lateral coefficient of 0.5 and passive lateral coefficient of 2.0. which are conservative values for granular soils and relatively conservative for low plasticity fine grained soils and soils consisting of mixture of coarse grained and low plasticity fine grained materials.

The requirements of NRCS Conservation Practice Standard 313, Waste Storage Facility, indicate a maximum control joint spacing in the slab of 10 feet for installations such as this. However, the joint spacing may be increased if steel reinforcing is added based on subgrade drag theory. Alternative joint spacing of 20 and 40 feet are provided in this design proportioning the reinforcing steel based on the sub-grade drag theory. The equipment anticipated to be operating on the slab is small to medium farm tractors and equipment with axel loads not exceeding 5000 pounds. For structural requirements this range of loading is considered to be lightly loaded slab on grade as classified by Corps of Engineers design methodology. This design conforms to the recommendations of Army TM 5-809-2/AFM 88-2, <u>Structural Design Criteria For Buildings</u> Chap 2 and appendix B and C for lightly loaded slab subject to typical exposure and sub-grade conditions. Typical sub-grade conditions are characterized by the absence of frost penetration, a wet environment and expansive soils and where volume changes due to change in moisture content are limited. Typical sub-grade conditions also include only USCS classified soils ML, any of the S and G groups or CL and CM where the modulus of sub-grade reaction is grater than 100 lb/in^3. Appendix A of this design report is a copy of Table c-2 from the TM 5-809-2 appendix c and may be used as a guide to estimating the modulus of sub-grade reaction.

Materials

Steel sheet used as roof covering and the exterior sidewalls is 29 ga. or heavier. Fastners shall be as recommended by the manufacturer. Purlins and wall girts are to be dimension lumber. The plywood interior wall is to be of treated plywood to protect against decay from the moist litter. It is reported that CCA (chromated copper arsenate) wood treatment is being phased out and being replaced by alternative treatments not containing arsenic. There are reports the new alternative treatments are more corrosive to metals in contact with the wood, particularly in the presence of high moisture in the wood. High quality galvanized or other high quality corrosion protected fastners should be used in attaching the treated plywood. Consideration should be given to painting the truss leg with a high quality corrosion resistant paint such as coal tar enamel where the treated plywood comes in contact with the metal.

Concrete shall be minimum 3000 psi. design strength. Reinforcing bar steel shall be grade 40, 50 or 60. Welded wire reinforcement shall be manufactured from 65,000 psi or 70,000 psi yield strength wire.

Lumber shall be standard dimensioned finished four sides. Requirements for the purlins are:

10 ft. truss spacing	2x6	#2 or better	Southern Pine
	2x4	select structural	Southern Pine
8 ft truss spacing	2x4	#2 or better	Southern Pine

Wall girts and closed end of the building shall be constructed of #2 or better of dimensions shown on the drawings.

This standard drawing is fully applicable when foundation soil is granular or low plasticity fine grained material. This includes USCS soil types GW, GP, SW, SP, AND SM, GM, SC, GC, ML AND CL with Plasticity Index less than 20. It is anticipated these materials possess only limited volume changes with changes in moisture content.

High Shrink –Swell foundation soils

Since the building is not rigid and does not have masonry walls it can withstand some differential movement with little or no distress with the possible exception of the floor slab. It is likely not economically feasible to provide a stiffened concrete floor slab, either post tensioned or conventionally reinforced, for this application. Extending the foundation wall deeper, to get below the zone of moisture change will enhance the stability of the building. In no case should a foundation of highly organic soils, or very loose, compressible low-density soil foundations used. Also care should be taken not have abrupt changes in foundation characteristics.